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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/856,209	05/18/2001	Kozo Nakamura	82822	6736

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	4

DATE MAILED: 05/14/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

AS-4

Office Action Summary	Application No.	Applicant(s)	
	09/856,209	NAKAMURA ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☐ Claim(s) _____ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-12 is/are rejected.

7)☒ Claim(s) 1 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 18 May 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Objections

1. Claim 1 is objected to because of the following informalities: The term "OSF" is objected to and it is suggested to replace "OSF" with the term with "oxidation-induced stacking faults". Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The purpose of the quotation marks in lines 4, 6 and 7 is indefinite.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in-
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

5. Claims 1, 2, 4, and 12 are rejected under 35 U.S.C. 102(e) as being anticipated by Hourai et al. (US 5,954,873).

In a method to produce silicon single crystal wafers essentially defect-free, Hourai et al. teaches the V/G ratio is maintained at 0.20-0.22 mm^2/°C.min at the center of the crystal and V/G ratio is maintained at 0.20-0.33 mm^2/°C.min at the outer surface of the crystal, where V is the pulling rate (mm/min) and G is the temperature gradient (mm/°C) (col 3, ln 41-57). Hourai et al also teaches the diameter of the OSF ring can be controlled by the single crystal pulling rate and the inside-crystal temperature gradient in the axial direction in a high temperature zone from the melting point of silicon to 1300°C (col 4, ln 43-57). Hourai teaches the OSF ring develops at the intermediate positions with a no-defect region, this reads on applicant's limitation of perfectly crystalline part, formed outside the ring and a scattering faults develop inside the ring at slower pulling rates and the OSF ring develops at the periphery at higher rates. (col 6, ln 1-20 and Fig 1A) Hourai also teaches the pulling rate is changed as the crystal is pulled to compensate for changes in the temperature gradient to maintain a constant V/G (col 6, ln 47-65) Hourai also discloses for medium velocity pulling a OSF ring develops at about one half the distance from the center of the silicon single crystal wafer (col 2, ln 1-8) Hourai teaches in Fig 4 a no defect region surrounding a OSF ring at various lengths of a silicon ingot.

Referring to claim1, Hourai teaches a no-defect region surrounds an OSF ring in Fig 4, which reads on applicant's limitation of a part of the silicon ingot, which can be used as wafers is improved.

Referring to claim 2, The ratio of G_{outer}/G_{center} can be determined by the ratio of V/G for the outer surface and the V/G of the center. The G_{outer}/G_{center} can be determined to be 1.1 for the ratio of 0.22/0.20.

Referring to claim 12, Hourai teaches the OSF ring diameter varies depending on the pulling rate and the diameter shrinks with decreasing pulling rates and Fig 4 illustrates the expanding of an OSF ring. It is inherent to Hourai's invention that the density of void defects would decrease because Hourai teaches a similar increase in the diameter of the OSF ring diameter.

6. Claims 7,8, and 10-12 are rejected under 35 U.S.C. 102(e) as being anticipated by Iida et al (US 5,968,264).

In a method of manufacturing a crystal ingot, Iida teaches a silicon single crystal grown through the use of a crystal pulling apparatus, where wafers were sliced from the thus-obtained silicon ingot (col 14, ln 20-67). Iida also teaches (Delta $G=G_e-G_c$) is not greater than 5°C/cm, where G_e is a temperature gradient at the periphery and G_c is a temperature gradient at the center portion of a growing crystal (col 10, ln 5-15). Iida also teaches a G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm)(Fig 8), where the G_e/G_c ratio can be determined to be 1.16. Iida also discloses that wafers were sliced from the thus-obtained silicon ingot (col 14, ln 20-67) Iida also teaches an OSF region is observed between a N region, a neutral region having few defects, and a vacancy rich region and interstitial rich region (col 15, ln 1-15 and Fig 10A) Iida also teaches the G_c is the temperature gradient at a central portion of the growing crystal both in an in-crystal descending zone, 1300-1000°C, or in the vicinity of the solid-liquid interface of the crystal,

melting point of silicon to 1400°C (col 4, ln 5-15 and col 4, ln 35-39), therefore G_c reads on applicant's $G1_{center}$ and $G2_{center}$. The value of 1.06x ($G1_{center}$ and $G2_{center}$)$^{-0.2}$ can be determined to be 0.68. Iida also teaches an OSF ring with an inner diameter of at least ½ a wafer inner diameter (Fig 10A) at a pulling speed of 0.62 mm/min.

Iida teaches a similar silicon ingot as applicant's ingot of claim 7, it is noted that claim 7 is a product by process relationship and it is the applicant's burden to show an unobvious difference.

Referring to claims 8 and 10, Iida teaches in Fig 10A an OSF ring with an inner diameter of at least ½ a wafer inner diameter at a pulling speed of 0.62 mm/min for silicon ingot and wafers are sliced from said ingot.

Referring to claim 11, Iida teaches a G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm), where G_e/G_c can be determined to be 1.16. Iida does not teach the inner diameter of an OSF ring is at least ½ a wafer inner diameter. It is inherent to Iida's invention to have an OSF ring of at least ½ a wafer inner diameter because he teaches producing a silicon ingot under similar pulling conditions as applicant.

Referring to claim 12, teaches the inner diameter of an OSF region increases as the pulling rate increases (Fig 10A). It is inherent to Iida's invention to reduce the density of void defects existing on the inside of an OSF ring because Iida teaches a similar increase in diameter of the OSF ring.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873).

Referring to claims 5, Hourai teaches a silicon wafer with an OSF ring with an inner diameter of less than 70% of an overall diameter and defect free zone occupying greater than 50% of a total surface area in Fig 1A. Hourai does not teach the ingot of Fig 10A is produced by a method taught by applicant. It is noted that claim 5 is a product by process relationship and it is applicant's burden to show an unobvious difference.

Hourai et al teaches all of the limitation of claim 6 as discussed previously, expect a silicon wafer with an OSF ring with an inner diameter of less than 50% of an overall diameter and a defect free zone occupying 75% or more of a total surface area. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai by slicing the ingot of Fig 4 at the 500 position using method known in the art to obtain a silicon wafer with an OSF ring with an inner diameter of less than 50% of an overall diameter and a defect free zone occupying 75% or more of a total surface area.

9. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al. (US 5,954,873) as applied to claim 2 above, and further in view of Luter et al. (US 5,922,127).

Hourai et al teaches all of the limitations of claim 3, except the single crystal ingot production is preformed while adjusting a distance between the silicon melt and a heat-shield member installed in a Czochralski method silicon crystal production equipment.

In an apparatus for pulling single crystals, Luter teaches a crucible mounted on a motorized turntable which raises the crucible to maintain the surface of the molten source material at a constant level as the ingot grows and the source material is removed from the melt (col 3, ln 60-65) Luter also teaches a heat shield (40) mounted above the upper surface of the molten source material (col 4, ln 32-37) It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai with Luter to avoid undesired changes in the thermal profile during the growth process.

10. Claim 9 is rejected under 35 U.S.C. 103(a) as being obvious over Iida et al. (US 5,968,264) in view of Hourai (US 5,954,873).

Iida teaches all of the limitations of claim 9, except the condition of $0.5<(\text{OSF ring inner diameter/crystal diameter})<1.06 \times (G1_{center} \times G2_{center})^{-0.2}$.

In a method of manufacturing a silicon wafer, Hourai et al teaches the two critical parameters for controlling the diameter of a OSF ring are a single crystal pulling rate and the inside-crystal temperature gradient (col 4, ln 44-59) It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida with Hourai because the OSF ring diameter could be controlled by adjusting the pulling velocity to optimize the size of the OSF ring.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Bihuniak et al (US 5,308,446) teaches as a single crystal is being pulled, the melt level in the crucible container also drops so that automatically controlled elevation of said crucible is commonly employed to avert undesired changes in the thermal profile during the growth process. Bihuniak et al also teaches heat shields are employed to carefully control axial and radial temperatures in the melt. (col 1, ln 20-35).

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

mjs
May 9, 2002

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